(2)

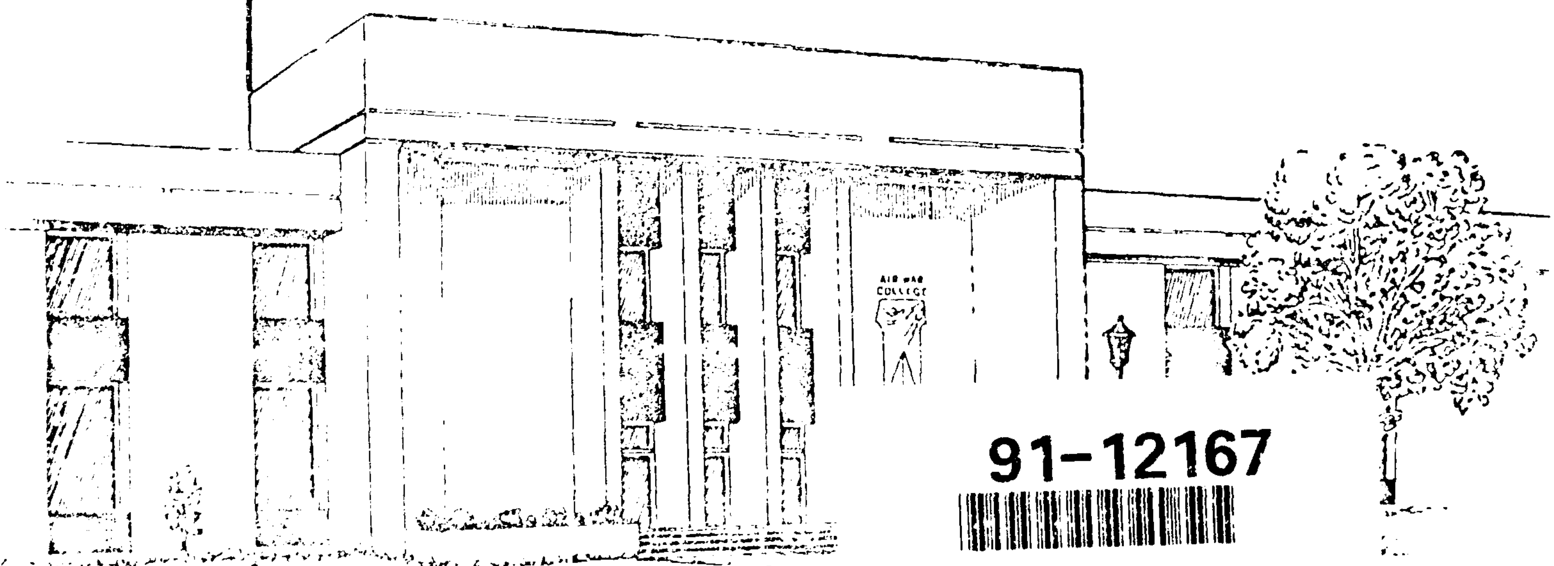
AIR WAR COLLEGE

RESEARCH REPORT

TECHNOLOGY AND THE EVOLUTION OF THE STRATEGIC AIR COMMAND AND THE AIR FORCE SPACE COMMAND

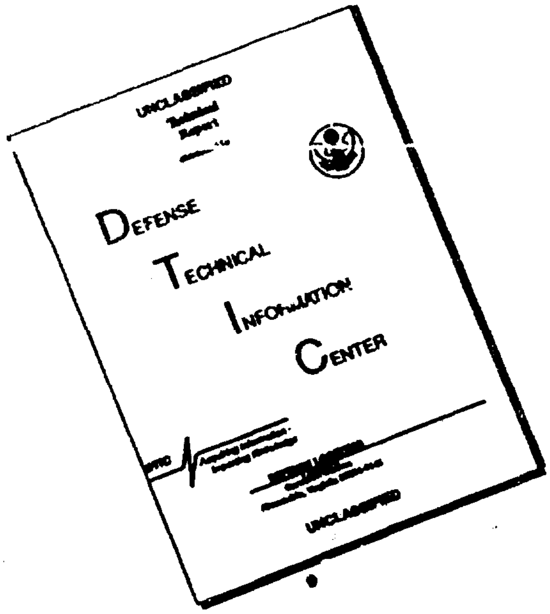
LIEUTENANT COLONEL GEORGE M. XIQUES, JR

1990



AIR UNIVERSITY
UNITED STATES AIR FORCE
MAXWELL AIR FORCE BASE, ALABAMA

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

AIR WAR COLLEGE

AIR UNIVERSITY

TECHNOLOGY AND THE EVOLUTION OF THE STRATEGIC AIR COMMAND AND THE AIR FORCE SPACE COMMAND

by

George M. Xiques, Jr.
Lieutenant Colonel, USAF

A DEFENSE ANALYTICAL STUDY SUBMITTED TO THE FACULTY

IN

FULFILLMENT OF THE CURRICULUM

REQUIREMENT

Advisor: Colonel Randall E. Wooten

MAXWELL AIR FORCE BASE, ALABAMA

April 1990

DISCLAIMER

This study represents the views of the author and does not necessarily reflect the official opinion of the Air War College or the Department of the Air Force. In accordance with Air Force Regulation 110-8, it is not copyrighted but is the property of the United States Government.

Loan copies of this document may be obtained through the interlibrary loan desk of Air University Library, Maxwell Air Force Base, Alabama 36112-5564 (telephone: (205) 293-7223 or AUTOVON 875-7223).

EXECUTIVE SUMMARY

TITLE: Technology and the Evolution of the Strategic Air Command and the Air Force Space Command. AUTHOR: George M. Xiques, Jr., Lieutenant Colonel, USAF

Today, there are great changes in the world situation and threats to US security. Paraphrasing Senator Nunn, we can watch the threat change nightly on TV and Congress is clamoring for defense cutbacks and new strategies for the multi-polar world in which the United States is finding itself.

The US strength has been its technological base. This is being seriously eroded by adversaries and allies through sale, theft, gift, and technology development by other nations. Technology has produced new capabilities and strengthened our allies. As their dependence on the United States for security dwindles, the United States is less welcome on their soil and is meeting increased competition.

To meet this multi-polar threat, US technologies in the strategic defense initiative (SDI) and the national aerospace plane (NASP) must be developed and deployed. To adapt these technologies, the roles, missions, and strategies of the USSPACECOM and SAC will have to evolve. The USSPACECOM must move toward becoming a defensive command employing high-ground doctrine through SDI and NASP technologies. SAC must evolve its capabilities also. As the result of this employment, crossover roles and missions will have to be solved.

BIOGRAPHICAL SKETCH

Lieutenant Colonel George M. Xiques, Jr., USAF, is a 1990 graduate of the Air War College. Colonel Xiques (B.S. in Industrial Technology, Memphis State University and a M.A. in Business Administration, Webster University) has over 12 years experience in reconnaissance and airborne command and control. He also has tours in C-130s and tanker contingency plans. Colonel Xiques was the Operations Officer for Detachment 1, 6th Strategic Wing, Shemya AFB, Alaska; Commander of the SAC Command Crew Division, Offutt AFB, Nebraska; and Commander of the 4th Airborne Command and Control Squadron Ellsworth AFB, South Dakota. He is a command pilot with over 5,000 hours and decorations which include 5 Air Medals, 2 Commendation Medals, and 2 Meritorious Service Medals.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Technology today has become a growth industry accounting for $35-40 billion a year in military research and development. It is both a problem solver and creator. As a problem solver, it enhances international security, economic growth, and social stability. However, the continuing growth and application of technology's secrets promotes constant change and challenges every facet of society. The military is not exempt, and current roles and missions will evolve or perish.[1:19, 2:6]

Technology's growth and application is not the true problem. It is the adaptation to it.[2:6] The threat is changing. Missiles capable of delivering chemical, biological, and nuclear warheads are being developed by approximately 15 countries. Russia's emphasis on technology exploitation will make it an even more credible threat to the United States in the next decade, even after its proposed reductions and arms control agreements.[3:11]

The United States has held to the use of technology to meet threats over the idea of mass, generally used by Russia. This is done because technology is viewed as the more economical means. However, in the last decade, the Russian Government out spent the United States in research and development by over 80 percent.(4:118) Today Russia has the world's only operational antisatellite system and enjoys an access to space much greater than that of the United States.(5:245)

This paper will examine emerging technologies and their impact on the missions of the Strategic Air Command and the United States Space Command to meet the changing threat and national security requirements of the United States as driven by technology growth.

CHAPTER II

EMERGING MILITARY TECHNOLOGIES

The growth of technology is manifesting itself in every facet of the world's societies. The result of this growth is that some people have found themselves passed by, frustrated, and confused about its uses.(6:4) Military experts, however, agree for the most part that technology is having a major effect upon national security and that it should be encouraged and even pushed in the key areas effecting defense.(7:7) America's leadership is linked directly to its ability to adapt to technological innovations which have improved its standard of living and promoted its economic strength into political strength. Americans have always used a "frontier spirit" to fix problems. Given this spirit it is easy to understand how technology has been used to advance America's security through a high technology military establishment.(8:12-13)

The difficulty today is how to spend dwindling defense dollars, forecast to be just over 4 percent of gross national product (GNP) by 1995 from a high of over 14 percent in the 1950s. Congress is already asking for a new US defense strategy despite the fact that Russia has yet to disarm and that the growth of the technological capabilities of other countries is expanding and producing the same kinds of threats once only in Russian hands.[9:18] Do we build B-2 bombers, close bases, or push for technologies which pr' ice the capability for worldwide surgical strikes? Today US defense systems are on the leading edge of technology and have the capability of being the winner in any conflict, but in tomorrow's wars being "firstest with the mostest" will not necessarily bring victory. Technologically superior weapon systems will be the key.[9:18, 10:2, 11:2] The following discussion is a brief synopsis of some significant technologies and what impact they could have.

Computers

Driving a car and figuring the family home finances are examples of how computers have infiltrated every facet of society. National defense is no exception and today's computer state-of-the-art is a result of defense needs.[8:12-13, 12:73-74] Today's computer systems have ten times the reliability requiring one fifth the space of older systems and with the same power. In addition, the costs have plummeted.[12:74-75] "Bubble memory"--a type of computer hardware, has made a large increase in capacity with reliability in harsh environments being increased up to 55 times. This was accomplished through solid-state mass storage.[13:42, 44] With the development of super computers such as the Cray X-MP by UC-Berkely which is capable of handling 105 million instructions per second, software has become the important force multiplier.[14:46]

An example of software as a force multiplier can be found in the DYNA3D program. This program began as a simple 5,000 line program in 1976 for the B-1 bomber. Today, 14 years later, it is an industry workhorse for hundreds of super computers and is a textbook case for how military research can have a wide impact ranging from crash worthiness of automobiles to the design of beer cans. As an added benefit, the civilian companies using this program have found errors in it and passed this information back to the military users. Today the military used DYNA3D in the design of aircraft windshields, engine blades, and other areas where this computer design system can help test stress and other functions of design in much less time and at much less cost.(15:78-81) Even with these types of programs and the introduction of very high-speed integrated circuits (VHSIC) which have increased data processing 50 to 100 times, it still requires 3 to 5 years for computer software to catch up with each new generation of computers.(16:66, 17:21, 12:77)

Computer and microchip technologies have made great strides through the efforts of business and government agencies such as the Defense Advanced Research Agency (DARPA). Electromagnetic pulse (EMP) hardening for protection during nuclear strikes is one area of great concern.(18:118, 19:59, 16:65) Fly-by-wire aircraft, remotely-piloted vehicles (RPV), command control, communications, and intelligence (C^3I) are all examples of how computer technology has been adapted by the military to solve threat related doctrine and strategy questions. Battle management is also seeing vast improvements through systems such as the Joint Surveillance Target Attack Radar System (Joint STARS) and the Joint Tactical Information Distribution System (JTIDS).(16:65, 20:45)

Avionics

Today's aircraft have far more avionic capabilities than hoped for a few years ago. This edge may be lost if future aircraft aren't capable of an estimated requirement for six times the computing power of today's aircraft.(14:49, 16:65) Even though much effort has been made to integrate flight and fire control systems, navigation, propulsion systems, electronic warfare systems, radars, and cockpit controls and displays much work still needs to be done. Pave Pillar is one of the programs currently under way. Its goal is to match expanded computer memory with the data processing speed of super chips to improve crew situational awareness and mission effectiveness through better integration of plane and crew.(21:45, 22:114, 23:216, 24:51)

The future holds great promise. Crews will be able to see the battlefield through computer enhanced windscreens. Occulometers will note the pilot's view and arm/release weapons with line-of-sight aiming and then change screens. All of this to take cockpit workload down allowing for more decision-making time.(12:77) Voice commanded computers will activate and fire weapons and distinguish targets. Through the use of television screens, the Aeronautical Systems Division (ASD) is developing a helmet which will project real-life images with the above capabilities.(23:216) As futuristic and advanced as these kinds of capabilities are, Soviet capabilities are quickly closing this technology advantage.(25:129, 26:95)

Stealth

The purpose of stealth technologies is to make aircraft invisible. If you are not found you are not destroyed. For the United States, this technology is being pushed with the B-2 bomber.(27:21) Its design and engineering encompasses radar absorption materials, vectoring nozzles, control surfaces which do not reflect radar, and engines with inlets and exhausts marked by airframe design to reduce reflectivity and electronic countermeasures.(27:28-29) While it appears that the United States has a substantial lead in this technology, no one government is without its development. If the B-2 bomber is produced for the field, it should revolutionize manned penetration tactics and provide a definite edge in air superiority.(28:22)

Future Aircraft

While speculative today, by the year 2000 we will see an aircraft that is airborne in 75 feet and accelerating in the vertical position by 200 feet to a speed beyond mach.(29:52) Technology advances and everything ASD and its contractors for the F-15 and F-16 have ever learned will be used to produce the

Advance Tactical Fighter (ATF) for operation in the mid-1990s.(21:43) The requirements for the ATF are mostly classified, but it is expected to have supersonic cruise, be maneuverable enough to win at long ranges and close in, have short field takeoff and landing (STOL) capability, be able to sustain engine/flight control damage without loss of aircraft, be supportable with minimum equipment, and be affordable.(29:55-56) The follow-on to the ATF is the National Aerospace Plane (NASP) which is expected to be at home in the atmosphere and in space. It will travel at 25 times the speed of sound and have engines, airframes, and avionics integrated into one system of independent elements.(21:43)

As a near term aircraft, the STOL Maneuvering Technology Demonstrator (SMTD) will be used to investigate, develop, and validate (1) advanced pilot/vehicle interface, (2) rough/soft field STOL landing gear, (3) a two-dimensional vectoring and reversing nozzle, and (4) integrated flight and propulsion controls.(29:53-54)

With all the advances in today's aircraft, the aircrew physical limits are already being reached. The increased maneuverability and turn rates of future aircraft coupled with high-g turns will only increase the problem.(30:11, 31:507) To combat this limitation, the Air Force is experimenting with drugs and g-suits today and for tomorrow, crews may well find themselves in a super cockpit that monitors the pilot's consciousness and recovers the aircraft when needed.(24:52)

Make no mistake, the United States and the Soviets are not the only ones in the race for better aircraft.(30:11) The British have the Experimental Aircraft Program (EAP), West Germany, Britain, Italy, and Spain are working on an air superiority fighter, referred to as the European Fighter Aircraft (EFA), and the French are testing the Rafale A Demonstrator.(32:71, 33:61, 34:79) The point being that if the United States is to maintain its edge over its adversaries, it will have to take advantage of its economic strengths and develop the right programs to continue growth and maintain its edge.(35:91)

Lasers

Today we see the use of lasers in medicine and industry. However, since their discovery by Albert Einstein in 1917, laser technology has not seen advancement which would warrant its use for doing damage to normal military targets. Today, operational gas dynamic lasers have only 5 percent of the power required to produce the beam. The chemical and free electron laser technologies do, however, hold promise for much higher efficiencies.

There has been significant progress since the first successful laser produced in 1962. There has been a large laser placed on a transport airplane to provide an airborne laser laboratory. These experiments and the knowledge gained from them will be of great benefit when it is time for deployment with space systems requiring high-intensity lasers. It is estimated that a laser capable of 10 megawatts with reasonably good optics could destroy the usefulness of satellites either by blinding them or destroying the solar cells required for power. In the near term, ground-based lasers are seen as the most probable threat while space-based systems adapted to work with x-rays are seen as the most probable over a time line of two decades.(36:20-22)

CHAPTER III

BREAKTHROUGH TECHNOLOGY

The Strategic Defense Initiative (SDI), also known as Star Wars, and the National Aerospace Plane (NASP) are US programs which hold significant potential for defense. These breakthrough technologies are defined for the purposes of this paper as those technologies which if successfully developed and deployed would greatly alter the balance of power and impact the missions of the United States Space Command (USSPACECOM) and the Strategic Air Command (SAC). SDI and the NASP are not just dreams on a drawing board. They represent years of development in technology and research which are culminating in the form of revolutionary weapon systems for both offensive and defensive phases of warfare tactics.

Strategic Defense Initiative

SDI, as introduced by President Reagan in March of 1983, was a challenge to the defense community to operate a research and technology program to review options to our offensive character of deterrence.[(37:47)] Its basic architecture included a host of technology advanced in the areas of C^3I, kinetic kill mechanisms, lasers, and directed energy weapons (DEW) designed to negate a missile attack with a layered defense which would attack incoming missiles and their warheads from the boost to the terminal phases.(37:48-53)

Today, largely due to budgetary reasons, SDI has been cut down to something much less than the original umbrella to render nuclear missiles obsolete. Complex and high-cost items such as directed energy weapons which include lasers and neutral particle beams have been put aside for further research and development until sometime in the twenty-first century. In their place are kinetic energy weapons.(38:60) These weapons are being evaluated by the Jasons, a group of 50 scientists. The two primary systems are "smart rocks" and "brilliant pebbles." The "smart rocks" concept is a space borne system of clustered, small rockets with non-nuclear warheads. The brilliant pebbles concept has individual rockets dispersed in space for attack on command. The Jasons will have to sort out the advantages of disbursement versus the disadvantage of an overhaul of the SDI architecture and the probabilities of success for each system.(38:62)

The Defense Acquisition Board (DAB) in October of 1989 produced a plan for phase I of SDI which lowered costs from $115.4 billion to $69.1 billion. The deployment decision was scheduled for the mid-1990s with a fully deployed system by the year 2000. The system relies on hundreds of space-based missile killers controlled by a boost surveillance and tracking system (BSTS) to destroy missiles during their boost phase and then, ground-based missiles with non-nuclear warheads designed to attack warheads which slip through the space-based system. As an added benefit, the BSTS could replace today's Air Force early warning satellites.(38:62-63)

Since SDI's introduction, much argument has taken place. The bottom line is that the Soviets have already made the decision. They are operating the world's only antiballistic missile (ABM) system and are upgrading it rapidly in violation of the Salt I ABM Treaty.(37:45) They have been at it for over 25 years and are estimated to have a 10 year lead and over 10,000 scientists assigned to SDI efforts.(26:94) They also have an antisatellite (ASAT) system which has been in operation for years.(37:46, 39:85) Their upgraded Galosh and Gazelle systems most probably can hit targets several hundred kilometers high with nuclear radiation damage to satellites well beyond this attitude. The Soviets have also violated the ABM Treaty of 1972 with their large phased-array radar at Krasnoyarsk.(26:94, 39:96)

The Soviet attack on SDI has been on two fronts. The first is a disorganization effort aimed at halting or least delaying SDI. This appears to be working.(40:25-26) The second is to use this delay to obtain and/or develop the technology necessary for them to deploy their own systems.(41:65-66)

Obviously, the deployment of a SDI system could drastically upset the current balance of power and make significant changes in tactics as well as change the offensive character of the US deterrent posture. Again, the nation who develops the technology to build the required systems and the ability to operate them once in place will have the edge in the balance of power.

National Aerospace Plane

The National Aerospace Plane (NASP) is a seed bed of technology development and represents an epic of technological frontiersmanship and long-term strategic thinking coupled with some short-term feasibility. The NASP or X-30 is being developed by a consortium of companies and government agencies. The project calls for an aircraft like vehicle capable of one stage earth-to-orbit with a go-around capability upon returning to its launch field along with the capability for hypersonic cruise.[42:18, 43:16]

The program was started in the 1980s and planned as a three-phase approach. The first phase was for early conceptual studies. The second was started in early 1986 and represents a major national program. Phase two whittled down contractors to two-engine makers, Pratt & Whitney and Rocketdyne, and three airframers--General Dynamics, McDonnell Douglas, and Rockwell International. Phase three, initiation of the construction and flight testing of the X-30, has been hoped for by mid-1990, but will most likely be delayed for budget reasons.[43:20-21]

The NASP program is, surprisingly, still a white program and is expected to foster many derivatives. One such NASP derivative vehicle (NDV) is expected to be a Shuttle

Transportation System (STS) replacement. The STS system currently costs $3,000 per pound. This equates to $115 to $300 million per launch. A NDV is expected to weight less than 800,000 pounds and cost $140 per pound. Launches would bring costs down to a relatively cheap $1 to $6 million. The benefits are great; payloads to orbit with low costs, on demand performance, and combined aircraft like reliability and operations.(42:19, 43:21)

Even if budget constraints significantly delay phase 3 or prevent the X-30 from being constructed, there are those who argue that the NASP has already had an enormous strategic benefit. The advancements in critical research and development technologies for hypersonic flight have gone further than any of the program's critics would have even believed.(43:16, 21) Significant testing has already been done on engine, airframe, and materials. These tests are growing as are the successes. In fact, the material consortium has done so well that they have formed a subsystem consortium.(42:19)

NDVs, other than a STS replacement, are certainly possible.(43:21) Hypersonic cruise capability alone is a significant leap ahead, of the current aircraft industry capability. This technology makes any point on the globe accessible in a matter of minutes. The implication for strategic and tactical planners are enormous. Yet even with this breakthrough in technological capability, the United States has major competition from countries besides Russia. Japan is certainly a major competitor in the field of hypersonics.(42:19)

CHAPTER IV

PROLIFERATION OF TECHNOLOGY

During the last 20 years, the United States has seen its technological eminence erode through numerous means. The sale/theft of technology has been especially helpful to the Soviets, the chief adversary in what has been predominantly a bipolar world since World War II. However, today with the changes in Europe and the Warsaw Pact along with the emergence of increasing competition from all over the globe including US allies such as Japan, the world is becoming multi-polar and the threat to US security is increasing.[44:132-139]

Sale/Theft of Technology

Technological leadership requires substantial investment and an aggressive pursuit of a large range of technologies to achieve and maintain systems superiority. While both the United States and the Soviet Union invest in research and development, the Soviets have been particularly successful in obtaining and exploiting Western technology. So well in fact that a real danger has developed and at present, we are being pressed hard with a clearly unfavorable trend in technology.[35:90, 44:132-133] The Soviets are accomplishing this both legally and illegally. They benefit in four key ways:

(1) direct, near-term technology breakthroughs to shore up weak areas, (2) over the long-term, it aides historically lagging Soviet technology, (3) it actually aids in boosting productivity, and (4) it allows for the transfer of R&D funds to military production.(4:118-119 44:135)

Unfortunately, the United States has aided Soviet collective operations. During the post-Watergate years, many US counterintelligence activities were dismantled or curtailed.(45:50) The Soviets responded by increasing their US operations by over 4,000 personnel while the FBI was reduced by 9 percent. The result is that Soviet agents outnumber US agents in their own country.(45:51) To make things worse, the United States during the mid-1970s reduced Defense Department security personnel by 42 percent which backlogged 84,000 investigations and forced 5-year reinvestigations of critical personnel to be suspended for several years.(45:51)

One must also remember that the United States is not the sole supplier of technology. Allied and Third World countries have aided in transferring technology. The open societies of the West are particularly vulnerable.(44:135) Traditional espionage being what it is, the West's open exchange of information makes it easy for anyone to obtain technology by outright purchase, up front or through fronts to include fraudulent marketing and export firms, bilateral industry projects, literature such as books, magazines, newspapers, etc. and even student exchanges.(44:135-159, 46:1)

In 1981, the US Department of Defense undertook a series of domestic and international initiatives in an effort to control the flow of Western technology. Domestically export license processing was improved, businesses are being educated and included in many vital issues, a classified and unclassified Military Critical Technologies List (MCTL) is being published as a guide, and the Secretary of Defense can withhold disclosure of technical data of military or space application to only those who need it legitimately.(47:300-301) Internationally, the Reagan administration worked to strengthen the Coordinating Committee (COCOM), the only organization through which all NATO nations except Iceland and Japan speak with one voice on the exportability of Western technology. The result has been a tightening of previously controlled technology and the inception of controls on robotics hardware/software, spacecraft, certain printed circuit boards and their related manufacturing equipment, and advance aero-engine technologies. With non-COCOM countries, the United States is negotiating and has entered into various agreements with other governments to establish a COCOM-level of protection for Western technology.(47:302)

The threat to our technological lead is real and growing. If the United States and its allies are going to protect this lead from being sold or given away, they are going to have to educate their populace and business firms to the danger and continue to strengthen their security programs and develop practical/workable controls while presenting a uniform front.(44:132-133, 48:47-48) An improved intelligence gathering capability could also be extremely effective in determining what agreements the United States and her allies should enter into for withholding the sale or transfer of emerging/existing technologies vital to their interests.(44:133)

Global Technology Development

It is ironic that today the United States finds itself with a diminishing Soviet threat as the Eastern European countries of the Warsaw Pact turn to democracy and the Soviet Union is having great difficulty with internal strife and its economy that the threat to the United States is coming increasingly from other countries of the world to include allies and Third World countries.(44:4-5, 133)

The last 30 years in industrialized Europe, countries have placed great emphasis on technology as a force multiplier both economically and militarily much the same as the United States. They, however, have subsidized their industries through direct financial support with economic policies and through direct aid. It is true that a stronger Europe has helped US security, but as industrialized Europe grows and expands its technology base and makes regional moves through organizations such as the European Community of 1992, the challenge to US security founded in its technology base is strong.(44:136)

In the Pacific rim, Japan and the Republic of Korea are certainly growing power houses which rely less and less on the United States as their strength grows. This is not intended to exclude other countries whose technical and economic powers are seeing significant gains. These include Taiwan, Singapore, China, and Hong Kong. Many of these nations are already strong competitors and are chipping away at the US technology edge. This will ultimately, if unchecked, effect security. In fact, Japan is already essential in any prolonged conflict for the United States.(44:136-138)

Third World countries are also growing in their ability to threaten US security. They are constantly being given and purchasing high-tech weapons. The Iranians and Iraqis developed short-range missile during their war. The Saudis now have ballistic missiles purchased from the Chinese. Over a dozen countries are expected to be able to deploy nuclear weapons by the year 2000. Even areas such as Central America are becoming very lethal in so called low-intensity conflict areas.(44:138)

In all, the US security is being threatened by technological proliferation on a global basis. Be it through sale, theft, or just plain individual development, the challenge is real and growing through both traditional enemies and allies. If the challenge is going to be met, the United States must protect and continue to develop and adapt technology for its security.(44:139, 49:44, 2:6)

CHAPTER V

TECHNOLOGY AND NATIONAL SECURITY

What price for security? The great debate continues over what, how much, and at what price. The effects of inflation set aside, the United States saw its R&D budget cut by 56 percent between the late 1970s and early 1960s.(35:90) Today, after a decade of having been out spent by 80 percent in R&D by the Soviets, the United States has a real threat in the narrowing edge of technology leadership which it has used for security against the overwhelmingly numerically superior forces it may have to combat.(26:118, 7:8)

Technology is inherently pushed by needs, innovation, and improvements. This is true everywhere in the world. The Soviets are no exception and are making use of the higher effectiveness afforded by the deployment of more sophisticated weapons. Examples of which can be found across the spectrum of both conventional and nuclear warfare. In many areas, they actually have the edge. Some of their latest fighter aircraft being one example.(7:9, 28:22, 35:90)

The US Air Force, in an effort to ensure a sound technology base and offset the negative trend in funding R&D budgets set a goal in 1984 of 2 percent a year of its Total Obligational Authority (TOA) to reinvigorate science and technology programs. However, with growing deficits and the passage of the Gramm-Rudman-Hollingsworth deficiency-reduction package, a 4.9 percent reduction in technology based funding occurred in the Fiscal Year 1986 budget. These type cuts simply mean that available monies have to be diverted to either buy more weapons systems being produced to reduce costs and aide in balancing the numerical odds or that weapons systems will have to be delayed, cutback, or eliminated to fund other emerging technologies such as SDI and Stealth.[35:91, 50:15]

Today, the broad trends in R&D are improving due to a new awareness of the importance of technology. The SDI budget was protected by the Reagan administration in hopes that it might someday reduce if not eliminate the threat of nuclear warfare.[35:91-92] This, however, has led to concern that such key technological areas as (1) computers and artificial intelligence, (2) propulsion systems, (3) materials and structures, (4) electronics, sensors, and satellites, (5) laser and beam technologies, (6) robotics, and (7) biotechnology and the integration of man and machine might be neglected or ignored despite the high potential payoff these technologies represent to the security of the United States and its allies.[35:91-92]

It is evident that the United States cannot persist in its current laissez-faire approach to competition in advanced technologies. It is also ironic that the threat is changing dramatically enough that the main competitor to the United States is becoming its own allies.[44:139] In this light, technology will drive security threats and missions to space and increasingly well-armed Third World countries are promoting the lethality of low-intensity conflict. Even areas involving nuclear, chemical, and biological threats are growing at increasing rates. Countries once kept in check by the Soviets will be free in the future and even allies will most likely oppose US interests/policies vis-a-vis the Third World. The long standing policy for US bases around the world for power projection is being cut short as more and more countries forbid US bases on their soil, as pointed out in the 1988 Report of the White House Commission on Integrated Long-Term Strategy.(44:139, 49:40-42)

The bottom line is that the threat proposed to the United States by changing technology is not only increasing, but changing what has been a bipolar world into a multi-polar world requiring US force projection from its shores to all areas including space.(49:40-43) It also means that emerging technologies should produce quality weapons and systems whose cost effectiveness is much greater than those of mass. This does not mean that quality over quantity will be cheap, but it should mean that quality will cope with quantity at a more affordable price especially if technologies are properly matched to provide weapon systems which truly produce the most effectiveness for the dollar spent. It is this approach that the United States has been following and should improve upon if it is to maintain its security in the face of an ever growing threat.(4:162-166, 44:139)

CHAPTER VI

TECHNOLOGY IMPACT ON THE US SPACE COMMAND AND THE STRATEGIC AIR COMMAND

Since the end of World War II, the US strategy has been based on the threat of a massive ground war in Europe. However, today after more than 40 years, the United States finds itself in a new world requiring new strategies.(57:12) There are those who claim that the threat is declining.(52:4) There are also those such as General Chain, the Commander in Chief of the Strategic Air Command (SAC), who are quick to point out that they worry about meeting an adversary's true capabilities and that the Soviet threat and others are not declining, but instead are growing through extensive modernization programs.(53:8) As discussed in Chapter IV, technology is growing and proliferating on a global basis. Today, the world is becoming more multi-polar. As Senator Sam Nunn, Chairman of the Senate Armed Services Committee, said "We've seen the threat change on TV every night." The spread of long-range missiles, nuclear weapons, and new capabilities of exploiting chemical and biological weapons are illustrations of this changing global threat due to emerging technologies.(3:11) These technologies are not a threat in themselves, but the failure of adapting to meet changing threats and technologies can be fatal. As strategies, roles, and missions had to adopt to changes brought about by the longbow, the tank, and the airplane, so must our leadership adapt to technology changes being brought about by space systems and new aircraft and weapon capabilities.(2:6) The USSPACECOM and SAC have evolved and must continue to adapt their roles and missions to meet changing threats. The following discussion of technology impact on the USSPACECOM and SAC will review changes brought about by technology and point out areas where changes in roles and missions will be required to effectively meet an evolving global threat to the security of the United States.

USSPACECOM

The application of space and its usefulness is not a new concept for the United States. It has, however, seen an intensifying and expanding role in the United States and world societies at affordable prices.(54:53-55) Lupton's four schools of doctrinal thought, sanctuary, survival, control, and high ground are evidence of this evolution and a means of explaining current US space policy.(55:209)

Lupton's four schools of doctrine range from the peaceful use only of space through defensive, active defense, and outright domination.(55:212-213) All four of these schools are evident in the present US space policy.(56:1-16) Starting with the sanctuary doctrine, the peaceful end of the spectrum, US policy was formed under the Eisenhower presidency. This doctrine stressed the right of way and openness to space along with a right to look into and fly over anyone's area. This fit the US capabilities and resources/technology at the time, for technology of the late forties and fifties had produced the German V-2 during World War II and the first satellite in 1957 launched by the Soviets. At this time, the problem for US interests and expansion was technology development and not so much the cost.[57:6-7, 55:212-214]

During the sixties and seventies, US technology experienced significant growth. Under President Kennedy, the United States set in motion goals for man-in-space and man-on-the-moon. With this emphasis on space and its potential came new systems for communications, weather tracking, and military usefulness.[57:7-10] As these capabilities and resources grew, so did the US reliance on these resources and their significance to national security.[36:1-2, 57:9-10] Out of this grew the doctrine of survivability. With this doctrinal policy came the need for redundant systems and protective measures against potential threats such as lasers, jamming, and antisatellite weapons. Also came tactics whose goal was to keep space weapon free.[55:213-215]

However, by the late seventies, reliance on space and its capabilities was growing vigorously. With this came the ability to verify treaties with space systems and to use space as a force multiplier. New weapons for both offense and defense have spurred great debates in all camps. Now, the issue of a nonmilitary space is all but a dead issue, the same as what happened to air warfare when guns were first put on airplanes to protect reconnaissance assets in World War I.(55:212-215) With these capabilities and the Soviet deployment of an antisatellite system and the upgrade of the Soviet Galosh missile system came the doctrine of control. This doctrine stressed active defense with some offense to assure US access to space while denying access to an enemy during times of conflict. This doctrine also sanctified the use of an US antisatellite system.(39:96, 55:214-216)

Space policy as set forth by President Reagan and supported by President Bush also includes elements of the high-ground doctrine, a military doctrine stating that control of the high ground signifies control of operations below. This doctrine is emphasized with the United States push for the development and deployment of a space system under the guise of the SDI set forth by President Reagan. This system is designed for US dominance in space and for the protection of the United States from a nuclear missile Armagedon.(55:212-216, 57:10-12)

Today's US space policy, as mentioned earlier, is an outgrowth of technology and the capabilities it affords. The US policy today and its resultant USSPACECOM organization reflects this growth.(57:10-11) The policy still stresses peaceful use of space with emphasis on commercial and private enterprise and with an emphasis on freedom of access much the same as the US policy of freedom of the seas. However, there are provisions for control doctrine and even high-ground doctrine due to the advocation of the need for protecting US access to space, denial of enemy access during hostilities, and the push for the high-ground doctrine through the research and development of the SDI.(57:11-12, 55:217, 56:1-7)

From the late fifties to the eighties, the US military services developed their own organizations and systems to exploit space system technologies for their own parochial interest. This method proved to be redundant and costly. As a result, in 1983 the Joint Chiefs of Staff took specific actions to form a unified space command. By late 1985, assignment of missions had been completed and the US Space Command was formed.(58:64)

The USSPACECOM combined the services' space organizations into one unified command which was to centrally control space assets and missions. Each service made up a department of the new command. There are three broad areas of responsibility: surveillance and warning, missile defense planning, and space operations. Operations are divided into two principal areas: aerospace defense and satellite operations.(59:83-85)

Given its role to control space assets and missions, the USSPACECOM is in a good position for providing guidance and structure for the future.(60:74) The next 10 years will offer many emerging technologies for exploitation and the future century offers capabilities only dreamed of.(61:60) Even today, there are many proponents of space who point to the inevitability of a "Space Force or Space Defense Force."(60:69) They have a good point, for the United States' growing dependence on space assets makes the need for systems such as those in SDI critical.(58:68, 61:61-63)

As discussed in Chapter III, SDI would not be deployed until the turn of the century and involves both land-based and space-based weapons.(38:62-63) These systems offer unique capabilities and challenges for coordination and execution of US forces. There will have to be corridors set up for safe passage of aircraft, command and control functions, and mission details will have to be coordinated. Even identification procedures offer significant problems for some of the systems currently being designed for SDI. SAC, in particular, is already role and mission crossover prone with the USSPACECOM. These areas will offer a great challenge for integrating doctrine and strategy with the realities of a military operation involving space and its fringes.(61:63)

SAC

SAC was formed following World War II for the purpose of providing the United States with long-range nuclear capability and thus, a deterrent to any potential aggressor. Today, SAC has grown into the Air Force's largest command. With technology's growth, SAC has seen B-29s replaced with more capable aircraft such as the B-52, B-1B, and now possibly the new stealthy B-2. SAC has also picked up the responsibility of the United States' land-based intercontinental ballistic missiles to include the MX Peacekeeper missile. Today SAC shoulders two legs of the United States' nuclear deterrent triad. In addition, it is responsible for conventional power projection with bombers, worldwide reconnaissance, refueling tasking for all US aircraft and survivable command and control systems.[62:87-88]

The eighties have been a perfect example of how SAC has had to adapt to new technologies in order to keep up with changing threats. The new underground command and control center at SAC headquarters is the latest in affordable technology. It is a fully computerized center which utilizes the Defense Satellite Communication System, Milstar, the Air Force Satellite Communication System, and the Ground Wave Emergency Network which also has some significant resistance to electronic magnetic pulse effects produced by nuclear weapons. To meet technology developments and their associated need for new strategy and tactics, the Strategic Warfare Center was established. New weapons have been or are being brought on line such as the B-2, Peacekeeper missile, and AGM-131A short-range attack missile. Tankers have been upgraded for greater capability and longer life. In addition, new missions such as the B-52G mission in conventional bombing and anti-ship and mine laying have been assigned to SAC. To help step-up to the need for power projection in a multi-polar world, SAC has also stepped up deployments and exercises to help train and educate its people for the complexities of performing its missions on a worldwide moments notice.(62:88)

According to AFM 1-1, the term aerospace includes all the area above the surface of the earth and its oceans and seas. This is also inclusive of space. This term is used in AFM 1-1 to explain the use of air power as aerospace power which is an indivisible entity designed to facilitate the meeting of objectives, threats, and opportunities. The "A" in SAC should, in the reality of AFM 1-1's definition, be "aerospace" instead of "air" for SAC has long been operating in space. Its reconnaissance aircraft operate at altitudes above 80,000 feet. Its bombers, tankers, and command and control systems rely on and extensively use space-based systems.(62:80, 138) Its missiles and early warning systems are most assuredly space use systems.(62:38, 145-146) The definition of indivisible aerospace power certainly fits SAC's worldwide power projection capabilities. It also fits into the 1988 White House Commission on Integrated Long-Term Strategy Report which stated that the United States needs to find alternatives to overseas bases. In support of this philosophy, new thinking in the Air Force XO community is exploring ways of propelling airpower from US shores and for developing doctrine which makes aerospace power truly indivisible in practice.(49:42)

Today SAC is the force most capable of meeting power projection from home shore needs. The future development of technologies found in systems such as SDI and the NASP will provide great opportunities for improving SAC's capabilities. In SDI technology, the BSTS will greatly enhance early warning and detection, a follow-on aircraft to the NASP would certainly bring worldwide strike capability within a matter of minutes. The enhancement to SAC's reconnaissance capabilities would certainly present significant possibilities.(38:62-63, 43:21, 42:19) However, as SAC's capabilities and emphasis on space increase to meet expanding capabilities and changing threats created by technology growth, so will the USSPACECOM grow in many of the same areas to include NASP derivatives and technologies and missions/roles created with the deployment of an SDI system. There are certainly many areas of possible conflict over resources and roles and missions.

Today it is clear that SAC and USSPACECOM have evolved policies, doctrine, strategies, missions, and organization to meet changing threats and technological capabilities in a changing world. One can debate whether they have been correct, but the evidence is clear that as technology grows and presents affordable capabilities for adapting to changing threats so does the US reliance on space and the impetus to evolve policies to match.

CHAPTER VII

CONCLUSIONS

Technology is a double-edge sword. The United States has thus far been able to maintain a lead in its development and use. However, as technology has become more sophisticated and its uses have become more competitive, the stakes have been raised to where technology initiatives can drastically effect world events and ultimately national security and the missions of its armed services.

This paper has thus far discussed some of today's emerging technologies and their associated problems in relation to national security and their impact on the USSPACECOM and SAC. The following narrative presents conclusions for possible courses of action in adapting the roles and missions of the USSPACECOM and SAC to technology growth.

The emerging military technological innovations in the areas of computers, avionics, stealth, future aircraft, and lasers are stunning and growing at increasing rates. Computer growth is everywhere. The advances in hardware are occurring much faster than the software for them. To help solve the lag time between hardware and software, the efforts of government, universities, and businesses should be both continued and encouraged. The advancements in computer use/value and the future importance of the computer's role in adapting to and solving technology problems posed to the accomplishment of the missions assigned to the USSPACECOM and SAC can not be overemphasized and continued development must be sustained.

Avionics technologies are what has been described as the quality edge needed for victory. The goals of integrating aircraft and crew to improve situational awareness and mission effectiveness are on target and seeing many successes. The future is very promising. However, if the United States is going to maintain an edge in combating its adversaries with a quality force as opposed to a numerical force, efforts will have to be stepped up across the board just to maintain its ever narrowing technological lead over the Soviet's and other growing threats.

Stealth technologies are extensive and far advanced. These revolutionary technologies must be developed ahead of US adversaries or the United States will have lost a strategic edge vital to national security.

Today's aircraft are already well beyond the level of performance, sophistication, and reliability hoped for just a few years ago, but the United States is in stiff competition from the Soviets and others, to include its allies. Continued efforts to push technology must be accomplished with vigor if the United States is to produce and take advantage of such aircraft as the NASP and its possible derivatives for both the USSPACECOM and SAC. Along with the accelerated advancement in aircraft technologies, the human element must also be considered. The idea of the super cockpit in conjunction with the g-suits and drugs now under development is very promising and should be pursued.

Laser technology has come a long way since its discovery in 1917. However, lasers are still a number of years of development away from being able to produce enough power to be militarily effective for space defense systems or for being used on aircraft for offensive weapons. Still, the progress since the first, successful laser in 1962 has been significant and its potential is too great not to continue a vigorous research and development program for deployment in systems for both the USSPACECOM and SAC.

The arena of breakthrough technologies is especially threatening to the strategic balance of power existing today. The NASP technologies are extensive and far advanced. The potential for launch to orbit and power projection to any part of the globe in minutes from American shores and at affordable prices is real. These revolutionary technologies must be developed by the United States ahead of its adversaries or the United States will have lost a strategic edge vital to its national security.

The technologies of SDI should no longer be argued. The Soviets are far ahead in many areas and are dedicated to the development and use of SDI technologies. While potentially destabilizing, the shift to a defensive posture and high-ground doctrine holds great promise for preventing nuclear war and the first one who develops and can deploy/control such a system as proposed will definitely tip the scales of strategic balance in his favor.

The potential of such breakthrough technologies as NASP and SDI are enormous and the penalty for not giving it the priority it deserves is just as great. The United States must maintain its efforts and not waiver from its present course of evolving the capabilities of the USSPACECOM and SAC through technology opportunities if it is to maintain or increase its national security and that of its allies.

The proliferation of technology is real and changing the world. Its process is growing at increasing rates and presents serious challenges to the United States. The Soviet successes at purchasing and stealing technology have provided great savings and advancement for them. If the United States and its allies are to prevent, curb, or control these losses, then such things as dismantling or large cut backs in agencies such as the FBI and the CIA must cease. These agencies can do much in the way of controlling technology loss and in determining the capabilities and needs of other governments. A uniform, well-educated front with practical and workable controls along with a good intelligence gathering capability must be achieved if the United States and its allies are to stop subsidizing the Soviets.

Global technology development has changed a relatively simple bipolar world into a multi-polar one in which the United States has found itself in competition with both its allies and adversaries. This multi-polar world has created significant security problems for the United States at all levels of competition. US strength has been its technological base and if it is to protect itself, it must pursue this lead and strength and adapt to emerging technology opportunities.

All things come with a price and the emerging technologies of today and tomorrow are no exception. The loss or lack of technology vital for national security is without overemphasis. The United States is now at a crossroad in history when a breakthrough, carelessness, or even ignorance will see its narrowing edge of technology leadership disappear. This represents a disaster to the national strategy of utilizing quality weapon systems to defeat a numerically superior force at a price to its tax payers which is more affordable than matching tank for tank and missile for missile. Therefore, a sound technology base must be maintained and the technologies which represent the most promise for the dollar invested must be pursued.

All the technologies and their proliferation discussed thus far have greatly changed the threats which the USSPACECOM and SAC must defeat. Their adaptations to emerging technological capabilities and a changing world situation have been those of continual evolution in capabilities, missions, strategies, and organizations. However, the future will continue to bring about conflicts between USSPACECOM and SAC over missions such as reconnaissance, command and control, and defense warning.

USSPACECOM is in a good position organizationally to grow into a space defense force as SDI systems are developed and deployed and they must be deployed if the United States is going to protect its space assets and protect the United States from a growing multi-polar threat involving missiles and the various nuclear, chemical, and biological warheads which they might be carrying. A NASP derivative for replacing the current space shuttle system is also imperative for getting payloads into space at affordable prices and with the regularity which space operations will require.

SAC is also in a good position for adapting to the new technologies of SDI and a NASP derivative. SDI promises great increases in surveillance and target location/identification and it should bring great strides in command and control systems. NASP derivatives promise a true capability to power project and operate real time reconnaissance to any joint on the globe within minutes.

Both USSPACECOM and SAC have thus far managed to sort missions, strategies, and resources in a fairly efficient way. However, as SDI technologies and NASP derivatives come on line, both commands will have to place much greater emphasis on sorting out the challenges created by cross over missions in space control, command and control, and offensive/defensive operations. Safe passage procedures and threat warning are just two examples of details which could mean defeat if not properly coordinated.

Space defense and power projection from US shores are real requirements for national security in the future as the US loses overseas basing, the world becomes even more multi-polar and the US reliance grows on space-based systems. To meet these threats, USSPACECOM must grow in capability through SDI technologies to protect space systems and the United States as a defensive command and SAC must continue it capability growth to include NASP technologies for strategic power projection and real time reconnaissance of areas not covered by space systems.

LIST OF REFERENCES

1. Kaufmann, William W. and Laurence J. Korb. The 1990 Defense Budget. The Brookings Institution, 1989, 51 pp.

2. Boyd, General Stuart R., USAF. "Leadership and High Technology." Air Power Journal. AFRP 50-2, Vol. III, No. 4, Winter 1989, pp. 4-10.

3. Wines, Michael. "Congress Starts Review of U.S. Military Posture. New York Times. January 24, 1990, p. 11.

4. Kross, Walter. Military Reform. Fort Lesley J. McNair, Washington DC, National Defense University Press, 1985.

5. Barker, Lieutenant Colonel Raymond H., USAF. "Space Control: A National Imperative." Department of Strategy and Forces Course Readings, Space Forces--SF 623, Air War College, November 1989, pp. 241-259.

6. Correll, John T. "It's Science--Not Magic." Air Force Magazine. December 1986, p. 4.

7. Lewis, Kevin N. "Technology and the Military Reform Debate." Rand Report. No. P-6901, July 1983, pp. 1-20.

8. McCortney, Lieutenant General Forrest S., USAF (Ret). "Technological Leadership in Space Programs Recalls America's Frontier Spirit." ROA National Security Report. Vol. 8, No. 2, February 1990, pp. 12-16.

9. "A New Strategy." Wall Street Journal. February 7, 1990, p. 18.

10. Correll, John T. "Butcher Knives Won't Do It." Air Force Magazine. Vol. 73, No. 2, February 1990, p. 2.

11. Rovai, Colonel A. P., USA. "Advanced Technology and EW Policy." Journal of Electronic Defense. Vol. 9, No. 6, June 1986, pp. 32-34.

12. Marlow, William J. "Computerization of Western Defense Systems." National Defense. Vol. LXIX, No. 399, pp. 73-77.

13. Weisenstein, Carol. "Bubble Memory. . . A Unique Memory Solution for the Military." Journal of Electronic Defense. Vol. 9, No. 6, June 1986, pp. 41-48.

14. Canan, James W. "The Software Crisis." Air Force Magazine. Vol. 69, No. 5, May 1986, pp. 46-52.

15. Wampler, Steve. "Look at What DYNA Does." Air Force Magazine. Vol. 73, No. 2, February 1990, pp. 78-86.

16. Morrocco, John. "Coming Up Short in Software." Air Force Magazine. Vol. 70, No. 2, February 1987, pp. 64-69.

17. Canan, James W. "Here Come the Superchips." Air Force Magazine. Vol. 67, No. 4, April 1984, pp. 48-54, Air War College Associate Programs, Vol. 1, Chapter 19, 19th Ed., pp. 20-25.

18. Byars, Captain Napoleon B., USAF. "EMP." Air Force Magazine. Vol. 68, No. 9, September 1985, pp. 113-118.

19. "Computer Survivability on the Battlefield." Defense Science & Electronics. Vol. 5, No. 5, May 1986, pp. 58-59.

20. Canan, James W. "Electronics for the High Ground." Air Force Magazine. Vol. 69, No. 7, July 1986, pp. 45-51.

21. ______________. "Era of the Starfighter." Air Force Magazine. Vol. 70, No. 1, January 1987, pp. 42-51.

22. Dornheim, Michael A. "Crew Situational Awareness Drives Avionics Developments." Aviation Week & Space Technology. Vol. 124, No. 25, June 23, 1986, pp. 114-116.

23. Reeves, Richard. "In Defense of a Nation." Popular Mechanics. Vol. 163, No. 7, July 1986, pp. 204-219.

24. Ropelewski, Robert R. "New Technologies Offer Quantum Leap in Future Fighter Capabilities." Aviation Week & Space Technology. Vol. 124, No. 25, June 23, 1986, pp. 48-52.

25. Klass, Philip J. "Maneuvering Attack System Prototype Undergoing Testing in F-16." Aviation Week & Space Technology. Vol. 124, No. 25, June 23, 1986, pp. 129, 131, 133.

26. Ulsamer, Edgar. "Intelligence Update on Soviet Power." Air Force Magazine. Vol. 69, No. 12, December 1986, pp. 90-95.

27. Biddle, Wayne. "The Real Secret of Stealth." Discover. Vol. 7, No. 2, February 1986, pp. 21-31.

28. Braybrook, Roy. "The Cutting Edge--New Fighter Technologies for the 90s'. Defense and Foreign Affairs. Vol. XIV, No. 5, May 1986, pp. 20-22.

29. Berry, F. Clifton, Jr. "2000 is (Nearly) Now." Air Force Magazine. Vol. 70, No. 2, February 1987, pp. 52-63.

30. Fink, Donald E. "Fighter Technology Advances." Aviation Week & Space Technology. Vol. 124, No. 25, June 23, 1986, p. 11.

31. Chambost, Germain and Paul Turk. "G-induced Loss of Consciousness--Combat Aircraft Pilots Head for Trouble." Interavia. May 1986, pp. 507-508.

32. Brown, David A. "British Experimental Aircraft Program Providing Insight Into New Technology." Aviation Week & Space Technology. Vol. 124, No. 25, June 23, 1986, pp. 71, 73, 76.

33. Feazel, Michael. "Germans Take Conservative Approach in Planning for New Aircraft." Aviation Week & Space Technology. Vol. 124, No. 25, June 23, 1986, pp. 61, 64, 69.

34. Lenorovitz, Jeffrey M. "Rafale Serves as Testbed for French Systems." Aviation Week & Space Technology. Vol. 124, No. 25, June 23, 1986, p. 79.

35. Marsh, General Robert T., USAF (Ret). "Our Tech Base Needs Attention." Air Force Magazine. Vol. 69, No. 7, July 1986, pp. 90-92.

36. America Plans for Space. National Defense University Press: Washington DC, 1984, p. 196.

37. Ulsamer, Edgar. "The Battle for SDI." Air Force Magazine. Vol. 68, No. 2, February 1985, pp. 45-53.

38. Rhea, John. "The Scaled Down Look of Star Wars." Air Force Magazine. Vol. 72, No. 10, October 1989, pp. 60-66.

39. Stares, Paul B. Space and National Security. The Brookings Institution: Washington DC, 1987, p. 219.

40. "Political Opposition to SDI Program Grows Nationwide." Aviation Week & Space Technology. Vol. 124, No. 22, June 2, 1986, pp. 25-26.

41. Lubkin, Dr Yale Jay. "What are the Soviets Up To?" Defense Science & Electronics. Vol. 5, No. 5, May 1986, pp. 65-66.

42. Covault, Craig. "Aero-Space Plane Leading U.S. Hypersonic Research." Aviation Week & Space Technology. February 27, 1989, pp. 18-19.

43. Harvey, David. "NASP Program on Track." Science & Technology. May 1989, pp. 16-21.

44. Soviet Military Power Prospects for Change 1989. United States Department of Defense, Office of the Secretary of Defense, Washington GPO, 1989, 159 pp.

45. Barron, John. "Why We Are Easy Prey for Spies." Readers' Digest. Vol. 128, No. 767, March 1986, pp. 49-54.

46. "Philippine Rebels Trade US Secrets for Weapons." Defense & Foreign Affairs Weekly. February 5-11, 1990, p. 1.

47. Annual Report to Congress: Fiscal Year 1987. United States Department of Defense, Office of the Secretary of Defense, Washington GPO, 1986.

48. Farrar, Donald L. "Technology Transfer: Pros and Cons." Military Science & Technology. Vol. 4, No. 7, July 1984, pp. 44-48.

49. Canan, James W. "Global Power from American Shores." Air Force Magazine. Vol. 72, No. 10, October 1989, pp. 38-45.

50. Gross, Richard C. "How Red is the Budget?" Defense Science & Electronics. Vol. 5, No. 5, May 1986, pp. 7-15.

51. "A New Defense for a New World." Chicago Tribune. February 11, 1990, p. V-12.

52. Tyler, Patrick C. "CIA's Webster Says Soviet Military Threat Declining." Washington Post. January 24, 1990, p. 4.

53. Kanworthy, Tom. "Eyeball-to-Eyeball at SAC Headquarters." Washington Post. February 14, 1990, p. 8.

54. Parrington, Lieutenant Colonel Alan J., USAF. "US Space Doctrine Time for a Change." Air Power Journal. Vol. III, No. 3, Fall 1989, pp. 51-61.

55. Lupton, Lieutenant Colonel David, USAF. "Space Doctrine." Department of Strategy and Forces Readings Book--Space Forces, SF 623. Air War College, Maxwell AFB AL, November 1989, pp. 209-219.

56. "U.S. National Space Policy." Office of the Press Secretary. November 16, 1989, Washington GPO, 1989, pp. 1-16.

57. Fuller, Thomas. "DOD in Space: A Historical Perspective." Department of Strategy and Forces Readings Book--Space Forces, SF 623. Air War College, Maxwell AFB AL, November 1989, pp. 6-12.

58. Piotrowski, General John L., USAF. "U.S. Space Command--Meeting National Security Needs in the Fourth Dimension." Department of Strategy and Forces Readings Book--Space Forces, SF 623. Air War College, Maxwell AFB AL, November 16, 1989, Washington GPO, 1989, pp. 64-68.

59. Herres, General Robert T., USAF. "Space Grows in Importance to the National Security." Department of Strategy and Forces Readings Book--Space Forces, SF 623. Air War College, Maxwell AFB AL, November 16, 1989, Washington GPO, 1989, pp. 83-87.

60. ______________________________. "The Future of Military Space Forces." Department of Strategy and Forces Readings Book--Space Forces, SF 623. Air War College, Maxwell AFB AL, November 16, 1989, Washington GPO, 1989, pp. 69-74.

61. Carlucci, Frank C. "DOD's Space Policy." Department of Strategy and Forces Readings Book--Space Forces, SF 623. Air War College, Maxwell AFB AL, November 16, 1989, Washington GPO, 1989, pp. 60-63.

62. "USAF Almanac." Air Force Magazine. Vol. 72, No. 5, May 1989, pp. 45-163.